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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ENVIRONMENTAL RESPONSE BRANCH
Edison, New Jersey 08837

May 2, 1991

MEMORANDUM:

SUBJECT: Prairie Metals Project Bench Scale Matrix Pre-Treatability

FROM: Harry Compton, Environmental Engineer
Environmental Response Team

TO: Warren Dixon, On-Scene Coordinator
Emergency Response Branch, Region IV

Attached you will find the quantitative results of the pre-treatability exercise on the balling clay matrix encountered at the Prairie Metals Site remediation. It essentially reiterates the information I related to you approximately two weeks ago. It appears that two separate pretreatment functions will substantially improve the mixing, where either one or preferably both may be incorporated into the Haztech/Aran system.

Prescreening the clays to a smaller size and/or premixing somewhere between 40 to 100 percent of the cement are two materials-handling options that were demonstrated successfully to minimize or eliminate the balling clays phenomena, bench scale. The exercise of slurrying the material only proved to be more difficult, and with the large volume of water addition required, there would be a commensurate increase in cost.

If you need any further information, please feel free to contact me at FTS 340-6751.

Attachment

PRAIRIE METALS PROJECT

BENCH SCALE EXPERIMENTATION
EDISON, NJ

APRIL, 1991

EPA Work Assignment No.: 2-475
Weston Work Order No.: 3347-21-01-3475
EPA Contract No.: 68-03-3482

TREATABILITY/FEASIBILITY STUDY REPORT

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1.0 INTRODUCTION

1.1 Site Background

The Prairie Metals site, located in Prairie, Mississippi, is solidifying clay-like, waste soils with the Westinghouse ARAN Unit. A waste:cement: water ratio of 8:2:1 is being used for the solidification of the waste. A problem with balling of the waste clays, resulting in a nonhomogeneous mixture being produced, led Warren Dixon, US Environmental Protection Agency (USEPA) Region IV On-Scene Coordinator (OSC), to ask Harry Compton, USEPA Environmental Response Team (ERT), for help with treatability/feasibility studies to solve this problem. In turn, the USEPA/ERT tasked its Response, Engineering, and Analytical Contract (REAC) to perform these studies. A five gallon pail of the clay-like, waste soils was received by REAC during the week of March 24, 1991.

1.2 Objective of this Study

The objective of this treatability/feasibility study, for the Prairie Metals site, was to determine what process would best solve the on-site material handling problem encountered with the contaminated, clay-like soils.

2.0 METHODOLOGY

Bench scale treatability/feasibility studies were performed in the REAC Engineering Evaluation Unit (EEU). All work that dealt with the contaminated soils was performed under a laboratory fume hood. For blending and mixing operations, a Hobart N-50 dough mixer was utilized. Portland Type I cement and deionized water were used for each study. Six studies were performed to determine the feasibility of two proposed solutions. The first proposed solution was to slurry the clay-like soils before addition of the cement to prevent balling of the clays. The second was to dry the clay-like soils by adding cement before the addition of water to prevent balling of the clays. The study parameters are tabulated in Table 1.

- STUDY #1:
  1. Clay-like soils were sieved to 1/4-inch and placed in the mixer.
  2. During mixing, water was added until the mixture looked pumpable (approximately 50% solids).
  3. Cement was added in a 1:1, cement: water ratio to solidify the waste.

- STUDY #2:
  1. Clay-like soils were sieved to 1/4-inch and placed in the mixer.
  2. 40% of the total cement to be added was placed in the mixer and mixed for approximately two minutes.
  3. Water and the remainder of the cement were then added to solidify the waste.

- STUDY #3:
  1. Clay-like soils were sieved to 1/4-inch and placed in the mixer.
  2. All of the cement was placed in the mixer and mixed for approximately two minutes.
  3. The water was then added to solidify the waste.

- STUDY #4:
  1. Clay-like soils were sieved to 1/4-inch and placed in the mixer.

2. All of the cement and water was added at once and mixed for approximately two minutes.

- STUDY #5:
  1. Clay-like soils were sieved to 3/8-inch and placed in the mixer.
  2. Steps 2 and 3 were the same as in study #3.

- STUDY #6:
  1. Clay-like soils were sieved to 5/8-inch and placed in the mixer.
  2. Steps 2 and 3 were the same as in study #3, with the exception of less water was added.

3.0 RESULTS

Results of the clay:cement: water added ratios, water added:cement ratios, total water (water added + water content of clays): cement ratios, and the percent clay, cement and water added are presented in Table 1.

Unconfined compressive strengths (UCS) were also performed on two of the study samples.

4.0 DISCUSSION OF RESULTS

- STUDY #1:

  The slurry was difficult for the mixer to produce. A high shear rate was necessary to break up the clay balls in the slurry.

- STUDY #2:

  The 1/4-inch clay balls were coated with the cement at first but were soon broken down to smaller balls. The clays never produced one lump, as was observed initially in STUDY #1. When the rest of the cement and water was added no problems were encountered in the final mixing. A UCS of 261 psi was measured after ten days of curing.

- STUDY #3:

  The results of this study were identical to STUDY #2 even though the cement was added all at once and more water was used to produce the final mix. A UCS of 194 psi was measured after ten days of curing.

- STUDY #4:

  The same mixture was used as in STUDY #2 except that everything was added all at once. The mixer had to work harder and longer to produce a uniform mixture.

- STUDY #5:

  Similar to what happened in STUDY #2, the 3/8-inch clay balls were coated with cement and were broken down into smaller balls. No problems were encountered in the final mixing.

- STUDY #6:

  As in STUDY #2 and STUDY #5 the 5/8-inch clay balls were broken down into smaller balls which later mixed well with the water to produce a uniform mixture.

5.0 CONCLUSIONS

STUDY #1 worked well once the material was slurred but an increase in the amount of water needed to slurry the clays resulted in increased cement usage. STUDY #4 was performed to mimic the problems that are being encountered on site. This study did show an increase in mixing time and work, and a slightly less homogeneous mixture was produced compared to the other studies. As shown in the results of STUDY #2 and STUDY #3, it did not matter whether 40% or 100% of the cement was added in the first step. Comparing the results of STUDIES #3, 5 and 6, regardless of whether 1/4-inch, 3/8-inch or 5/8-inch sieved clay was used initially, the clay balls were all broken down to approximately the same size before the water was added. In conclusion, the proposed slurry process would be as difficult a material handling problem as the site is dealing with now. Although the final mixture would be more homogeneous, the additional cement and water required to implement this process would make it less cost effective.

The proposed drying of the clays with cement worked very well on the bench scale. Power requirements of this initial mixing appeared minimal, and the longer the retention time, the better the mixing. Varying amounts of water were used to see if this had any effect on the final homogeneity. Water usage of 50mls, 60mls, and 75mls (STUDIES #2, 6 and 5) was tested for the same amount of cement and clay. The 50ml mixture appeared too dry and small specks of unmixed clays were left in the final mixture. The 60ml and 75ml mixtures appeared to solve this problem, but the 75ml mixture appeared too wet.

6.0 RECOMMENDATIONS

In order to solve the material handling problem, it is recommended that the cement, all or part, be added before any mixing is performed or water added. Screening of the clays to the smallest possible size is also recommended to facilitate mixing.

Two possible solutions to the processing problem are:

- During the screening of the clays (1-inch or less preferably) a portion of the total cement (20%) can be added to the screening to coat the clay balls. This will prevent the clays from forming larger balls before they are processed.

- Another mixer (i.e. a continuous ribbon blender) can be used to preblend the clays and cement before going to the final process. It is still preferable to screen the clays to the smallest possible size and add the cement in this stage to prevent balling. This will also lower the power requirements of the mixer.

Not being sure of how the original treatability study was performed, or what basis was used to evaluate the study, a 25% cement addition seems high for this waste. From our tests, a UCS of at least 190 lbs/in^2 was measured; this is well over the 50 lbs/in^2 EPA requirement. It is also recommended that the final mixture be kept hydrated enough to form a homogeneous mixture, since it was determined that the drier the mix, the less homogeneous the final mix will be.

TABLE 1
TREATABILITY STUDY PARAMETERS
PRAIRIE METALS PROJECT
EDISON, NEW JERSEY
APRIL, 1991

STUDY PARAMETERS	STUDY #1	STUDY #2	STUDY #3	STUDY #4	STUDY #5	STUDY #6
AMOUNT OF CLAY (g)	400	400	400	400	400	400
SIEVE SIZE (in)	0.25	0.25	0.25	0.25	0.375	0.625
1st ADDITION	175mls water	40g cement	100g cement	100g cement 50mls water	100g cement	100g cement
2nd ADDITION	175g cement	50mls water 60g cement	75mls water	none	75mls water	60mls water
CLAY:CEMENT:WATER RATIO	8:3.5:3.5	8:2:1	8:2:1.5	8:2:1	8:2:1.5	8:2:1.2
WATER ADDED:CEMENT RATIO	1:1	1:2	1:1.33	1:2	1:1.33	1:1.67
TOTAL WATER:CEMENT RATIO	1:0.64	1:0.67	1:0.57	1:0.67	1:0.57	1:0.63
% CLAY	53.3	72.7	69.6	72.7	69.6	71.4
% CEMENT	23.3	18.2	17.4	18.2	17.4	17.9
% WATER ADDED	23.3	9.1	13.0	9.1	13.0	10.7
UCS (lbs/sq in)	N/T	261	194	N/T	N/T	N/T

N/T = NO TESTING PERFORMED